IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant:	Younes Jalali	§	TC/A.U.:	2123
Filed:	12/19/2006	§	Examiner:	Mary C. Jacob
Title:	System And Method For Determining Flow Rates In A Well	§	Docket No.:	SHL.0423US (103.0009)

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF PURSUANT TO 37 C.F.R § 41.37

Sir:

The final rejection of claims 1-17, 19-29, 31-33, and 37-38 is hereby appealed.

I. REAL PARTY IN INTEREST

The real party in interest is Schlumberger Technology Corporation.

II. RELATED APPEALS AND INTERFERENCES

None.

III. STATUS OF THE CLAIMS

Claims 1-17, 19-29, 31-33, and 37-38 have been finally rejected and are the subject of this appeal.

Claims 18, 30, and 34-36 have been cancelled.

IV. STATUS OF AMENDMENTS

No amendment after the final rejection of July 13, 2010 has been submitted. Therefore, all amendments have been entered.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The following provides a concise explanation of the subject matter defined in each of the independent claims involved in the appeal, referring to the specification by page and line number and to the drawings by reference characters, as required by 37 C.F.R. § 41.37(c)(1)(v). Each element of the claims is identified by a corresponding reference to the specification and drawings where applicable. Note that the citation to passages in the specification and drawings for each claim element does not imply that limitations from the specification and drawings should be read into the corresponding claim element. Note also that the cited passages are provided as examples, as other passages in the specification or drawings not cited may also be relevant to the corresponding claim elements.

Independent claim 1 recites a method of determining production rates in a well, comprising:

determining (Fig. 5:75) a model of temperature as a function of zonal flow rates in the well (Spec., p. 6, ¶ [0024], ln. 1-6);

measuring (Fig. 5:76) temperatures at a plurality of locations in the well (Spec., p. 3, ¶ [0016], ln. 2-4; p. 6, ¶ [0024], ln. 7-8); and

inverting (Fig. 5:77), by a computer, the measured temperatures by applying the model to determine an allocation of production rates from different producing zones in the well, wherein the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the production rates, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model (Spec., p. 7, ¶ [0024], ln. 8-12; p. 24, ¶ [0043], ln. 1-3; p. 26, ¶ [0050], ln. 1 - p. 27, ¶ [0052], ln. 15).

Independent claim 12 recites a method of determining flow rates in a well, comprising:

measuring (Fig. 3:60) temperatures at a plurality of points along the well having a plurality of well zones and a plurality of liquid phases (Spec., p. 3, ¶ [0016], ln. 2-4; p. 6, ¶ [0022], ln. 4-6);

measuring (Fig. 3:62) a total flow rate from the well (Spec., p. 3, ¶ [0016], ln. 4; p. 6, ¶ [0022], ln. 6-8); and

determining (Fig. 3:64), by a computer, flow rates of the plurality of liquid phases through the plurality of well zones via the measured temperatures, wherein the determining comprises inverting the measured temperatures by applying a model, wherein the inverting comprises allocating by the total flow rate among the plurality of well zones (Spec., p. 3, ¶ [0016], ln. 4-9; p. 6, ¶ [0022], ln. 8-10; p. 7, ¶ [0024], ln. 8-12; p. 24, ¶ [0043], ln. 1-3; p. 26, ¶ [0050], ln. 1 - p. 27, ¶ [0052], ln. 15).

Independent claim 19 recites a system, comprising:

a temperature sensor (Fig. 1:40) deployable with a production completion along a wellbore to sense temperature data at a plurality of wellbore locations during production (Spec., p. 4, ¶ [0019], ln. 2-3); and

a processor system (Fig. 1:42; Fig. 4:66) configured to receive the sensed temperature data and allocate flow rates from a plurality of wellbore zones based on the sensed temperature data, wherein the processor system is configured to allocate the flow rates by inverting the sensed temperature data using a temperature forward model, wherein the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the flow rates, where the optimization problem minimizes an error between the sensed temperature data and corresponding calculated temperature data from the model (Spec., p. 4, ¶ [0019], ln. 4-8; p. 6, ¶ [0023], ln. 1-3; p. 7, ¶ [0024], ln. 8-12; p. 24, ¶ [0043], ln. 1-3; p. 26, ¶ [0050], ln. 1 - p. 27, ¶ [0052], ln. 15).

Independent claim 26 recites a method, comprising:

deploying (Fig. 3:58) a distributed temperature sensor (Fig. 1:40) along a wellbore (Spec., p. 4, ¶ [0019], ln. 2-3; p. 6, ¶ [0022], ln. 2-6);

utilizing a model of temperature as a function of fluid flow rates in the wellbore (Spec., p. 6, ¶ [0024], ln. 1-6);

obtaining (Fig. 3:62) measured temperatures from the distributed temperature sensor (Spec., p. 3, ¶ [0016], ln. 4; p. 6, ¶ [0022], ln. 6-8);

determining (Fig. 3:64) fluid flow rates in corresponding wellbore zones using the measured temperatures in conjunction with the model, wherein the determined fluid flow rates are calculated using an optimization algorithm that solves an optimization problem, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model (Spec., p. 3, ¶ [0016], ln. 4-9; p. 6, ¶ [0022], ln. 8-10; p. 7, ¶ [0024], ln. 8-12; p. 24, ¶ [0043], ln. 1-3; p. 26, ¶ [0050], ln. 1 - p. 27, ¶ [0052], ln. 15).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Claims 1-7, 12-15, 17, 19-22, 25-29, 31, 32, 37 and 38 were rejected under 35 U.S.C. § 102(e) as anticipated by Shah (U.S. Patent Publication No. 2004/0084180).

B. Claims 8-10 and 33 were rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Finsterle (iTough2 User's Guide).

C. Claim 11 was rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Akin (Analysis of Tracer Tests with Simple Spreadsheet Models).

D. Claim 16 was rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Curtis (U.S. Patent No. 3,913,398).

E. Claims 23 and 24 were rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Tubel (U.S. Patent No. 6,082,454).

VII. ARGUMENT

The claims do not stand or fall together. Instead, Appellant presents separate arguments for various independent and dependent claims. Each of these arguments is separately argued below and presented with separate headings and sub-headings as required by 37 C.F.R. § 41.37(c)(1)(vii).

A. Claims 1-7, 12-15, 17, 19-22, 25-29, 31, 32, 37 and 38 were rejected under 35 U.S.C. § 102(e) as anticipated by Shah (U.S. Patent Publication No. 2004/0084180).

1. Claims 1-7.

It is respectfully submitted that the § 102 rejection of claim 1 is clearly erroneous, since Shah fails to disclose at least the following element of claim 1:

> inverting, by a computer, the measured temperatures by applying the model to determine an allocation of production rates from different producing zones in the well, wherein **the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the production rates, where the optimization problem <u>minimizes</u> an error between the measured temperatures and corresponding temperatures calculated by the model**.

As purportedly disclosing the foregoing bolded subject matter of claim 1, the Final Office Action cited the following passages of Shah: Fig. 3 (elements 108, 110, 112); ¶ [0006], lines 5-8; ¶¶ [0037]-[0038]. 7/13/2010 Office Action at 4-5, 32.

The cited passage in ¶ [0006] of Shah states that flow rates are estimated by iteratively comparing measured static and transient well conditions with a model. However, there is no hint here regarding an optimization problem that **minimizes** an error between measured temperatures and corresponding temperatures calculated by a model.

Paragraphs [0037]-[0038] of Shah refer to Fig. 3, which includes steps 108, 110, and 112 cited by the Final Office Action. Step 108 compares actual transient data to calculated expectations of the model. Shah, ¶ [0037]. Shah notes that the modeling comparisons may be reiterated until an approximate match (within acceptable tolerances) is obtained between calculated well properties and measured well properties. *Id.*, ¶ [0038]. However, reiterating to accomplish an approximate match to within **acceptable** tolerances, is **not** the same as solving an optimization problem that **minimizes** an error between the measured temperatures and model-calculated temperatures.

The Examiner argued that Shah discloses that "if the 'deviation', or 'error' [of Shah] is too large (does not fall within an acceptable tolerance level), changes are made to the model and the process is reiterated until the calculated and measured temperature deviation is within an acceptable tolerance level." 7/13/2010 Office Action at 32. Shah discloses that the process reiterates until the deviation between measured and model-calculated quantities are approximately "good enough," *i.e.*, to within **acceptable** tolerances. The Examiner appears to have equated "acceptable" or "good enough" with "minimizing," which is clearly incorrect.

Shah's teachings are quite different from solving an optimization problem that **minimizes** an error between the measured temperatures and model-calculated temperatures, as claimed.

In view of the foregoing, it is clear that Shah fails to disclose the subject matter of claim 1, and thus, the rejection of claim 1 and its dependent claims is clearly erroneous.

Reversal of the final rejection of the above claims is respectfully requested.

2. Claims 12-15.

Independent claim 12 is also allowable over Shah. Claim 12 recites measuring a total flow rate from the well, and where determining flow rates comprises inverting the measured temperatures by applying a model, where the inverting comprises allocating the total flow rate among the plurality of well zones.

The Examiner cited the following passages of Shah as purportedly disclosing the subject matter of claim 12: ¶¶ [0009], [0011], [0031], [0036]-[0038], [0041]. 7/13/2010 Office Action at 8-11, 33. Paragraph [0009] of Shah refers to estimating flow rates for plural well locations. Paragraph [0011] refers to measuring a wellhead flow rate. Paragraph [0011] also refers to modeling a well using the measurements to measure flow rates. However, there is no hint in these passages of Shah regarding inverting measured temperatures by applying a model that comprises **allocating** the **total flow rate** <u>**among**</u> the plurality of well zones.

Paragraph [0031] of Shah refers to a data path 31 that extends into the wellbore 12, where the data path 31 supplies transient data to the model 30, such as measured pressure data 42 and temperature data 43 measured at multiple downhole locations. Paragraph [0036] of Shah refers to measuring volumetric flow rates at the wellhead 22. However, there is no teaching or hint in these passages of Shah of using a total flow rate from the well to allocate the total flow rate

among the plurality of well zones in performing inverting to determine flow rates of a plurality of liquid phases through the plurality of well zones.

Paragraphs [0037]-[0038] of Shah relate to reiterating the processing until the deviation between measured and model-calculated quantities are within acceptable tolerances. Paragraph [0041] of Shah refers to providing the wellhead flow rate to the model. However, there is also no hint in these passages that applying the model comprises **allocating** a total flow rate **among** a plurality of well zones. The statement in ¶ [0041] of Shah that the wellhead flow rate is an input to the model does not provide any hint that the model is applied to **allocate** a total flow rate from the well among the plurality of well zones.

Therefore, it is clear that claim 12 and its dependent claims are allowable over Shah.

Reversal of the final rejection of the above claims is respectfully requested.

3. Claim 17.

Claim 17 depends from claim 12 (indirectly), and is therefore allowable for at least the same reasons as base claim 12. Moreover, claim 17 further recites:

> wherein inverting the measured temperatures comprises utilizing an optimization algorithm that solves an optimization problem for calculating the flow rates, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model.

As explained above in connection with claim 1, Shah clearly does not disclose the foregoing subject matter of claim 17. Therefore, claim 17 is further allowable for the foregoing reasons.

Reversal of the final rejection of the above claim is respectfully requested.

4. Claim 37.

Claim 37 depends from claim 1 and is therefore allowable for at least the same reasons as claim 1. Moreover, claim 37 further recites:

> measuring a total flow rate of the well at a wellhead; and
>
> allocating, by the model, the total flow rate among the different producing zones based on the measured temperatures.

As discussed above in connection with claim 12, Shah clearly does not provide any teaching of the foregoing combination of elements. Therefore, claim 37 is further allowable for the foregoing reasons.

Reversal of the final rejection of the above claim is respectfully requested.

5. Claims 19-22, 25.

Independent claim 19 recites a system comprising:

> a temperature sensor deployable with a production completion along a wellbore to sense temperature data at a plurality of wellbore locations during production; and
>
> a processor system configured to receive the sensed temperature data and allocate flow rates from a plurality of wellbore zones based on the sensed temperature data, **wherein the processor system is configured to allocate the flow rates by inverting the sensed temperature data using a temperature forward model, wherein the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the flow rates, where the optimization problem minimizes an error between the sensed temperature data and corresponding calculated temperature data from the model**.

For reasons similar to those stated above with respect to claim 1, Shah clearly does not provide any teaching of at least the bolded language of claim 19 set forth above. Therefore, claim 19 and its dependent claims are allowable over Shah.

Reversal of the final rejection of the above claims is respectfully requested.

6. Claims 26-29, 31, 32.

Independent claim 26 recites a method comprising:

> deploying a distributed temperature sensor along a wellbore;
>
> utilizing a model of temperature as a function of fluid flow rates in the wellbore;
>
> obtaining measured temperatures from the distributed temperature sensor;
>
> determining fluid flow rates in corresponding wellbore zones using the measured temperatures in conjunction with the model, **wherein the determined fluid flow rates are calculated using an optimization algorithm that solves an optimization problem, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model**.

For reasons similar to those stated above with respect to claim 1, it is clear that Shah does not disclose at least the bolded language of claim 26 set forth above.

Therefore, claim 26 and its dependent claims are allowable over Shah.

Reversal of the final rejection of the above claims is respectfully requested.

7. Claim 38.

Claim 38 depends from claim 19, and is therefore allowable for at least the same reasons as claim 19. Moreover, claim 38 further recites:

> a sensor to measure a total flow rate of the wellbore at a wellhead,
>
> wherein the processor system is configured to allocate, using the model, the total flow rate among the plurality of wellbore zones based on the sensed temperature data to allocate the flow rates.

For reasons similar to those stated above with respect to claim 12, Shah clearly does not provide any teaching or hint of the foregoing combination of elements. Therefore, claim 38 is further allowable for the foregoing additional reasons.

Reversal of the final rejection of the above claim is respectfully requested.

B. Claims 8-10 and 33 were rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Finsterle (iTough2 User's Guide).

1. Claim 8.

In view of the allowability of base claim 1 over Shah, the obviousness rejection of claim 8 over Shah and Finsterle has been overcome. Moreover, claim 8 further recites:

> wherein determining the degree of certainty comprises determining a degree of error in the model, the method further comprising compensating for the determined degree of error in the model in performing the inverting.

The Examiner conceded that Shah fails to disclose the subject matter of claim 8. 07/13/2010 Office Action at 24. Instead, the Examiner cited Finsterle as purportedly disclosing the claimed subject matter missing from Shah. *Id.* at 25. The specific passages of Finsterle relied upon by the Examiner include the following: p. 2, ¶¶ 1, 2; p. 4, ¶ 1; p. 4, § (2), p. 7, item (4). *Id.*

Page 2, ¶ 2, of Finsterle explains that errors in the conceptual model can have large impact on model predictions. According to Finsterle, the "ultimate goal is to assess the best model and its parameters for predicting the behavior of a dynamic flow system." Finsterle, p. 3, ¶ 1. As further explained in Finsterle, the models are calibrated to laboratory or field data. *Id.*, p. 4, ¶ 1. Page 7, § (4) of Finsterle states that the model output and measured data are compared only at the discrete points in space and time, which are the so-called calibration points. The purpose of performing such comparison in Finsterle is to **iteratively <u>update</u> the model parameters**, such that an optimal model is produced. *Id.*, p. 8, § (8).

The goal in Finsterle of iteratively updating a model based on comparing model output and measured data, is different from the subject matter of claim 8. According to claim 8, a degree of certainty is determined in the production rates allocated (based on application of the model), where the degree of certainty includes a degree of error in the model. Thus, according to

claim 8, some error is assumed to be present in the model. Claim 8 further recites that such determined degree of error in a model is **compensated** for in performing the inverting. Since the model of Finsterle has been iteratively updated based on measured data to be in a form acceptable to an operator, it is clear that Finsterle would **not** perform any compensating for a determined degree of error in the model in performing the inverting, since the operator would assume that such error in the model does not exist.

Thus, even if Shah and Finsterle could be hypothetically combined, the hypothetical combination of the references would not have led to subject matter of claim 8. Therefore, claim 8 is further allowable for the foregoing reasons.

Reversal of the final rejection of the above claim is respectfully requested.

2. Claim 9.

Claim 9 depends from claim 1 and is therefore allowable for at least the same reasons as claim 1. Moreover, claim 9 further recites:

> wherein determining the degree of certainty comprises determining a degree of error in the measured temperatures, the method further comprising compensating for the determined degree of error in the measured temperatures in performing the inverting.

As discussed above in connection with claim 8, Finsterle relates to iteratively updating the model based on comparison of model output and measured data, such that the model is in an acceptable form assumed to be error-free. In view of the model refinement performed in Finsterle, there would be no reason in Finsterle to compensate for a determined degree of error in the measured temperatures in performing the inverting. Therefore, even if Shah and Finsterle could be hypothetically combined, the hypothetical combination would not have led to the subject matter of claim 9. Claim 9 is therefore further allowable for the foregoing reasons.

Reversal of the final rejection of the above claim is respectfully requested.

3. Claim 10.

Claim 10 depends from claim 1 and is therefore allowable for at least the same reasons as claim 1. Moreover, claim 10 is allowable for similar reasons as stated above with respect to claims 8 and 9. Note that claim 10 recites "a degree of error in well parameter values," whereas claim 9 recites "a degree of error in the measured temperatures." It is clear that the hypothetical combination of Shah and Finsterle does not provide any teaching or hint of compensating for the determined degree of error in the well parameters in performing the inverting.

Claim 10 is therefore further allowable for the foregoing reasons.

Reversal of the final rejection of the above claim is respectfully requested.

4. Claim 33.

Claim 33 depends from claim 26, and is therefore allowable for at least the same reasons as claim 26. Moreover, claim 33 is further allowable for similar reasons as stated above with respect to claim 8.

Reversal of the final rejection of the above claim is respectfully requested.

C. Claim 11 was rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Akin (Analysis of Tracer Tests with Simple Spreadsheet Models).

1. Claim 11.

In view of the allowability of base claim 1 over Shah, the obviousness rejection of dependent claim 11 over Shah and Akin has been overcome.

Reversal of the final rejection of the above claim is respectfully requested.

D. Claim 16 was rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Curtis (U.S. Patent No. 3,913,398).

1. Claim 16.

In view of the allowability of base claim 12 over Shah, the obviousness rejection of dependent claim 16 over Shah and Curtis has been overcome.

Reversal of the final rejection of the above claim is respectfully requested.

E. Claims 23 and 24 were rejected under 35 U.S.C. § 103(a) as unpatentable over Shah in view of Tubel (U.S. Patent No. 6,082,454).

1. Claims 23, 24.

In view of the allowability of base claim 19 over Shah, the obviousness rejection of dependent claims 23 and 24 over Shah and Tubel has been overcome.

Reversal of the final rejection of the above claims is respectfully requested.

CONCLUSION

In view of the foregoing, reversal of all final rejections and allowance of all pending claims is respectfully requested.

Respectfully submitted,

Date: March 25, 2011

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VIII. <u>APPENDIX OF APPEALED CLAIMS</u>

Claims 18, 30, and 34-36 have been cancelled.

The claims on appeal are:

1. A method of determining production rates in a well, comprising:

determining a model of temperature as a function of zonal flow rates in the well;

measuring temperatures at a plurality of locations in the well; and

inverting, by a computer, the measured temperatures by applying the model to determine an allocation of production rates from different producing zones in the well, wherein the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the production rates, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model.

2. The method as recited in claim 1, wherein determining the model comprises determining the model for a single-phase liquid producing well.

3. The method as recited in claim 1, wherein determining the model comprises determining the model for a multi-layer producing well.

4. The method recited in claim 1, wherein determining the model comprises determining the model for a multi-layer, single-phase liquid producing well.

5. The method as recited in claim 1, wherein determining the model comprises determining the model for a multi-layer, multi-phase liquid producing well.

6. The method as recited in claim 1, wherein measuring the temperatures comprises measuring temperature with a distributed temperature sensor.

7. The method as recited in claim 1, wherein the inverting comprises determining a degree of certainty in the production rates allocated.

8. The method as recited in claim 7, wherein determining the degree of certainty comprises determining a degree of error in the model, the method further comprising compensating for the determined degree of error in the model in performing the inverting.

9. The method as recited in claim 7, wherein determining the degree of certainty comprises determining a degree of error in the measured temperatures, the method further comprising compensating for the determined degree of error in the measured temperatures in performing the inverting.

10. The method as recited in claim 7, wherein determining the degree of certainty comprises determining a degree of error in well parameter values, the method further comprising compensating for the determined degree of error in the well parameter values in performing the inverting.

11. The method as recited in claim 1, wherein using the optimization algorithm comprises utilizing a generalized reduced gradient optimization algorithm.

12. A method of determining flow rates in a well, comprising:

measuring temperatures at a plurality of points along the well having a plurality of well zones and a plurality of liquid phases;

measuring a total flow rate from the well; and

determining, by a computer, flow rates of the plurality of liquid phases through the plurality of well zones via the measured temperatures, wherein the determining comprises inverting the measured temperatures by applying a model, wherein the inverting comprises allocating by the total flow rate among the plurality of well zones.

13. The method as recited in claim 12, wherein measuring the temperature at the plurality of points comprises utilizing a distributed temperature sensor.

14. The method as recited in claim 12, wherein determining the flow rates comprises constructing the model of temperature as a function of zonal flow rates in the well, and using the model to invert the measured temperatures in allocating the flow rates from the plurality of well zones based on the measured total flow rate.

15. The method as recited in claim 12, wherein determining the flow rates comprises determining flow rates of oil and water phases during production.

16. The method as recited in claim 12, wherein determining the flow rates comprises determining flow rates of fluid injected into each of the plurality of well zones.

17. The method as recited in claim 14, wherein inverting the measured temperatures comprises utilizing an optimization algorithm that solves an optimization problem for calculating the flow rates, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model.

19. A system, comprising:

a temperature sensor deployable with a production completion along a wellbore to sense temperature data at a plurality of wellbore locations during production; and

a processor system configured to receive the sensed temperature data and allocate flow rates from a plurality of wellbore zones based on the sensed temperature data, wherein the processor system is configured to allocate the flow rates by inverting the sensed temperature data using a temperature forward model, wherein the inverting comprises using an optimization algorithm that solves an optimization problem for calculating the flow rates, where the optimization problem minimizes an error between the sensed temperature data and corresponding calculated temperature data from the model.

20. The system as recited in claim 19, wherein the temperature forward model specifies temperature as a function of zonal flow rates.

21. The system as recited in claim 19, wherein the temperature sensor comprises a distributed temperature sensor.

22. The system as recited in claim 19, wherein the processor system is configured to allocate flow rates in a multi-layer, multi-phase liquid producing well.

23. The system as recited in claim 19, wherein the production completion comprises an electric submersible pumping system.

24. The system as recited in claim 19, wherein the production completion comprises a gas lift system.

25. The system as recited in claim 19, wherein the wellbore is oriented generally vertically.

26. A method, comprising:

deploying a distributed temperature sensor along a wellbore;

utilizing a model of temperature as a function of fluid flow rates in the wellbore;

obtaining measured temperatures from the distributed temperature sensor;

determining fluid flow rates in corresponding wellbore zones using the measured temperatures in conjunction with the model, wherein the determined fluid flow rates are calculated using an optimization algorithm that solves an optimization problem, where the optimization problem minimizes an error between the measured temperatures and corresponding temperatures calculated by the model.

27. The method as recited in claim 26, wherein determining the fluid flow rates comprises inverting the measured temperatures using the model to obtain the fluid flow rates.

28. The method as recited in claim 26, wherein deploying the distributed temperature sensor comprises deploying the distributed temperature sensor in a generally vertical wellbore.

29. The method as recited in claim 26, wherein deploying the distributed temperature sensor comprises deploying the distributed temperature sensor in a deviated wellbore.

31. The method as recited in claim 26, wherein determining the fluid flow rates comprises determining flow rates for a single-phase liquid producing well.

32. The method as recited in claim 26, wherein determining the fluid flow rates comprises determining flow rates for a multi-phase liquid producing well.

33. The method as recited in claim 26, further comprising:

determining a model error, a measurement error, and a well parameter error; and

compensating for the model error, measurement error, and well parameter error when inverting using the model to determine the fluid flow rates.

37. The method as recited in claim 1, further comprising:

measuring a total flow rate of the well at a wellhead; and

allocating, by the model, the total flow rate among the different producing zones based on the measured temperatures.

38. The system as recited in claim 19, further comprising:

a sensor to measure a total flow rate of the wellbore at a wellhead,

wherein the processor system is configured to allocate, using the model, the total flow rate among the plurality of wellbore zones based on the sensed temperature data to allocate the flow rates.

IX. EVIDENCE APPENDIX

None.

X. RELATED PROCEEDINGS APPENDIX

None.